SAD: How Does Cloudiness Matter?

A (very preliminary) Reading List

September 30, 2025

Economic Behavior

Fleming, D., Grimes, A., Lebreton, L., Maré, D., & Nunns, P. (2018). Valuing sunshine. *Regional Science and Urban Economics*, *68*, 268–276

Abstract:
Sunlight influences people's housing decisions, but city intensification may reduce sunlight exposure for neighboring properties, causing a negative externality. There are hitherto no rigorous estimates of the cost of this externality. Using over 5000 observations on house sales in Wellington, New Zealand, we derive the willingness to pay for an extra daily hour of sunlight, on average, across the year. After controlling for locational sorting and other considerations in an hedonic regression, we find that each extra daily hour of sunlight exposure is associated with a 2.6% increase in house sale price. This estimate is robust to a variety of alternative specifications in which we test for non-linearities and amplifying factors by interacting sunlight with a range of other influences. Our results can be used to price negative externalities caused by new development, so replacing or augmenting regulations designed to address impacts of development on neighbors' sunshine.

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Glimcher, P. W., & Tymula, A. (2017). Let the sunshine in? The effects of luminance on economic preferences, choice consistency and dominance violations. *PLOS ONE*, *12*(8), e0181112. https://doi.org/10.1371/journal.pone.0181112

Abstract:
Weather, in particular the intensity and duration of sunshine (luminance), has been shown to significantly affect financial markets. Yet, because of the complexity of market interactions we do not know how human behavior is affected by luminance in a way that could inform theoretical choice models. In this paper, we use data from a field study using an incentive-compatible, decision task conducted daily over a period of two years and from the US Earth System Research Laboratory luminance sensor to investigate the impact of luminance on risk preferences, ambiguity preferences, choice consistency and dominance violations. We find that luminance levels affect all of these. Age and gender influence the strength of some of these effects.

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Guven, C., & Hoxha, I. (2015). Rain or shine: Happiness and risk-taking. *The Quarterly Review of Economics and Finance*, *57*, 1–10

Abstract:
In this paper, we focus on the effects of weather, such as sunshine, as an exogenous shifter of happiness using happiness data at the individual level, and estimate sunshine as a predictor of happiness. Then we relate the predicted happiness to risk-taking. By doing so, we estimate a relationship, stronger than a simple correlation, between happiness and risky behavior. Weather changes, and sunshine in particular, have substantial influences on personal happiness. However, unexpected weather changes appear to be more important than expected changes for happiness. We include several risk measures such as subjective risk-taking and financial assets in our analysis. Happier people appear to be more risk-averse in general and more specifically in financial decisions, and choose accordingly safer investments. This might be explained by the fact that happy people take more time for making decisions and have more self-control. In addition, predicted happiness affects expectations about longevity and inflation. Happy people expect to live longer and accordingly seem more concerned about the future than the present, and expect less inflation.

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Lagerborg, A., Pappa, E., & Ravn, M. O. (2023). Sentimental Business Cycles. *The Review of Economic Studies*, *90*(3), 1358–1393. https://doi.org/10.1093/restud/rdac053

Abstract:
We estimate the dynamic causal effects of consumer sentiment shocks in the US. We identify autonomous changes in survey evidence on consumer confidence using fatalities in mass shootings as an instrument. We find the instrument to be significant for an aggregate index of consumer expectations and also back up the identification scheme with micro evidence that exploits the geographical variation in mass shootings. Sentiment shocks have real macroeconomic effects. A negative sentiment shock is recessionary: It sets off a persistent decline in consumer confidence and induces a contraction in industrial production, private sector consumption and in the labour market, while having less evident nominal effects. Finally, sentiment shocks explain a non-negligible part of the cyclical fluctuations in consumer confidence and real macroeconomic aggregates.

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Quante, L., Willner, S. N., Otto, C., & Levermann, A. (2024). Global economic impact of weather variability on the rich and the poor. *Nature Sustainability*, *7*(11), 1419–1428. https://doi.org/10.1038/s41893-024-01430-7

Abstract:
Temperature and precipitation variability and extremes impact production globally. These production disruptions will change with future warming, impacting consumers locally as well as remotely through supply chains. Due to a potentially nonlinear economic response, trade impacts are difficult to quantify; empirical assessments rather focus on the direct inequality impacts of weather extremes. Here, simulating global economic interactions of profit-maximizing firms and utility-optimizing consumers, we assess risks to consumption resulting from weather-induced production disruptions along supply chains. Across countries, risks are highest for middle-income countries due to unfavourable trade dependence and seasonal climate exposure. We also find that risks increase in most countries un-

der future climate change. Global warming increases consumer risks locally and through supply chains. However, high-income consumers face the greatest risk increase. Overall, risks are heterogeneous regarding income within and between countries, such that targeted local and global resilience building may reduce them.

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Sun, Q., Cheng, X., Gao, S., Chen, T., & Liu, J. (2023). Sunshine-induced mood and SEO pricing: Evidence from detailed investor bids in SEO auctions. *Journal of Corporate Finance*, *80*, 102411. https://doi.org/10.1016/j.jcorpfin.2023.102411

Abstract:

We examine sunshine-induced mood and its impacts on investors' bidding decisions in the primary market where seasoned equities are offered. Analyzing a unique database that records seasoned equity offerings (SEOs) investors' locations, identities, and bidding information, we examine the degree to which sunshine exerts an influence on investors' bidding behaviors (and subsequently SEO discounts) from two dimensions: sunshine intensity and duration. We find that investors exposed to stronger sunshine intensity or longer sunshine duration submit a higher bid price for SEOs, thus leading to lower offer discounts. We also find that mood misattribution and risk-taking act as channels to rationalize such a sunshine effect. Our moderating analyses indicate that the documented impact strengthens in the case of greater uncertainty, less-frequent bidders, retail investors, and lower levels of investment. These sunshine effects impact failed bids, SEO participation and SEOs' long-term performance. Our study provides original evidence that investors in the primary market can be influenced by a sunshine-induced mood, which, in turn, determines the cost of equity financing.

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Educational outcomes

Komulainen, K., Hakulinen, C., Lipsanen, J., Partonen, T., Pulkki-Råback, L., Kähönen, M., Virtanen, M., Ruuhela, R., Raitakari, O., Rovio, S., & Elovainio, M. (2022). Long-term residential sunlight exposure associated with cognitive function among adults residing in Finland. *Scientific Reports*, *12*(1), 20818. https://doi.org/10.1038/s41598-022-25336-6

Abstract:

While sunlight may influence cognitive function through several pathways, associations of residential sunlight exposure with cognitive function are not well known. We evaluated associations of long-term residential sunlight exposure with cognitive function among a representative cohort of 1838 Finnish adults residing in Finland who underwent comprehensive cognitive assessment in midlife. We linked daily recordings of global solar radiation to study participants using residential information and calculated the average daily residential exposure to sunlight for four exposure time intervals: 2 months, 1 year, 2 years and 5 years prior to the date of the cognition assessment. Associations of the residential sunlight exposure with cognitive function were assessed using linear regression analyses adjusting for season, sex, age, and individual- and neighborhood-level socioeconomic characteristics. Greater average residential sunlight exposure over 2 and 5 years prior to the cognitive function assessment was associated with better global cognitive function (b = 0.13, 95% CI = 0.01, 0.25; b = 0.17, 95% CI = 0.05, 0.29, per 1 MJ/m2

difference in sunlight exposure), while no associations with global cognitive function were observed at shorter exposure time intervals. In domain-specific analyses, greater residential exposure to sunlight over 1, 2 and 5 years prior to the cognitive function assessment was associated with better performance on new learning and visual memory (b = 0.10, 95% CI = 0.00, 0.20; b = 0.16, 95% CI = 0.04, 0.28; b = 0.19, 95% CI = 0.08, 0.31) and sustained attention (b = 0.15, 95% CI = 0.05, 0.25; b = 0.18, 95% CI = 0.06, 0.30; b = 0.17, 95% CI = 0.05, 0.29), but worse performance on reaction time (b = - 0.12, 95% CI = - 0.22, - 0.02; b = -0.15, 95% CI = - 0.28, - 0.02; b = - 0.18, 95% CI = - 0.30, - 0.05). Residential sunlight exposure was not associated with executive function. These findings suggest long-term residential sunlight exposure may be an environmental factor influencing cognitive function among a cognitively healthy cohort residing in Northern Europe. Further studies in populations residing in different geographical locations are needed.

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Kuhlenengel, M., Konstantzos, I., & Waters, C. E. (2021). The effects of the visual environment on k-12 student achievement. *Buildings*, *11*(11), 498. https://doi.org/https://doi.org/10.3390/buildings11110498

Abstract:

The varying indoor environments among educational buildings can have an impact on students' ability to learn. This study looks at field data from 220 classrooms in the Midwest, United States, over a two-year period, to analyze the effects of the visual environment on student achievement. The visual environmental metrics considered within this scope include the three new view metrics introduced within the EN 17037 "Daylight of Buildings" standard (Horizontal Sight Angle, Outside Distance of View, and Number of View Layers), as well as standard daylight and electric lighting metrics, focusing on light availability and glare. To capture student achievement, math and reading achievement scores were used, accompanied by auxiliary demographic variables. This allowed for a correlational analysis using multivariate regression. Among the notable results of this study, there was a positive effect of the availability of view on reading achievement. However, another view metric, Horizontal Sight Angle, showed a significant negative interaction with free and reduced lunch recipients on reading achievement, indicating that demographics can also have a significant role in the way the visual environment can affect learning.

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Political Behavior

Horiuchi, Y., & Kang, W. C. (2017). Why Should the Republicans Pray for Rain? Electoral Consequences of Rainfall Revisited. *American Politics Research*. https://doi.org/10.1177/1532673X17745631

Abstract:

Existing studies, most importantly Gomez, Hansford, and Krause, provide empirical support for an idea often embraced by popular media: The vote share of the Republican Party (as the percentage of total votes) increases when it rains, because the magnitude of decrease in turnout is larger among Democratic vis-a-vis Republican supporters. Considering the compositional nature of aggregated data, we show that the alleged Republican advantage derives in part from an increase

in the number of votes for the Republican Party. Based on the extensive literature of psychology and related fields, we provide a possible interpretation of this counter-intuitive empirical finding. Methodologically, our evidence suggests that researchers must be alert when using rainfall as an instrument to estimate the causal effects of voter turnout on electoral outcome.

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Health

Dos Santos, E. A., Cavalheiro, L. A. M., Rodrigues, D., Machado-Rodrigues, A., Silva, M.-R., Nogueira, H., & Padez, C. (2024). Are sun exposure time, dietary patterns, and vitamin d intake related to the socioeconomic status of portuguese children? *American Journal of Human Biology*, *36*(9), e24109. https://doi.org/https://doi.org/10.1002/ajhb.24109

Abstract:

Objectives

To investigate the association among sun exposure time, vitamin D intake, dietary patterns, and socioeconomic status in Portuguese children.

Methods: Participants aged 3–11 years (50.1% females) were recruited from public and private schools (n = 118) in the districts of Coimbra (n = 2980), Lisbon (n = 3066), and Porto (n = 2426). Parents reported their children's daily sun exposure time during the summer season and reported children's food consumption, including vitamin D food sources, using standardized questionnaires. Parents' education level was used as a proxy measure to the socioeconomic status (SES). The principal component factor analysis (PCA) method was used to identify dietary patterns. The eight dietary patterns identified were labeled in: "fast food", "rich in vitamin D", "sugary drinks", "vitamin D", "candies", "supplements", "rich in calcium" and "vegetables/healthy". Linear regression analyses were performed to investigate the association between sun exposure time and dietary patterns according to SES.

Results: A total of 4755 children were included. Children from high SES had significantly longer sun exposure time (p¡0.001) and more frequently consumed vitamin D supplements (p¡0.001). "Fast food" pattern showed a negative association with sun exposure time in medium and high SES (p=.014 and p¡0.001, respectively).

Conclusion: Children with lower SES spend less time exposed to the sun, consume fewer dietary sources of vitamin D, and consume more foods rich in fat and sugar.

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Filteau, S., Rehman, A. M., Yousafzai, A., Chugh, R., Kaur, M., Sachdev, H. P. S., & Trilok-Kumar, G. (2016). Associations of vitamin D status, bone health and anthropometry, with gross motor development and performance of school-aged Indian children who were born at term with low birth weight. *BMJ Open*, *6*(1), e009268. https://doi.org/10.1136/bmjopen-2015-009268

Abstract:

Objectives: There is little information regarding motor development of children born at term with low birth weight (LBW), a group that constitutes a large proportion of children in South Asia. We used data from infancy and at school age from a LBW cohort to investigate children's motor performance using causal inference.

Design: Cross-sectional follow-up study. Setting: Delhi, India. Participants: We recruited 912 children aged 5 years who had participated in a trial of vitamin D for term LBW infants in the first 6 months of life. Outcome measures: We focused on gross motor development, using the Ages and Stages Questionnaire (ASQ) gross motor scale and several measures of motor performance. We examined the effects on these of current anthropometry, vitamin D status and bone health, controlling for age, sex, season of interview, socioeconomic variables, early growth, recent morbidity, sun exposure and animal food intake.
Results: In adjusted analyses, stunted children (height-for-age Z less than -2) took longer to run 20 m (0.52 s, 95 percent CI 0.35 to 0.70; p less than 0.001) and had greater odds of a failing score on the ASQ (OR 3.00, 95 percent CI 1.41 to 6.38, p=0.004). Greater arm muscle area was associated with faster run time, and the ability to perform more stands and squats in 15 s. Poorer vitamin D status was associated with the ability to perform more stands and squats. Lower tibia ultrasound Z score was associated with greater hand grip strength. Early growth and current body mass index had no associations with motor outcomes.
Conclusions: Current HAZ and arm muscle area showed the strongest associations with gross motor outcomes, likely due to a combination of simple physics and factors associated with stunting. The counterintuitive inverse associations of tibia health and vitamin D status with outcomes may require further research.

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Hirakawa, H., Terao, T., Kohno, K., Sakai, A., & Kawano, N. (2025). Affective temperaments and light preference. *Frontiers in Psychiatry*, *16*. https://doi.org/10.3389/fpsyt.2025.1598849

Abstract:

Background: If affective temperaments are associated with light preference (brightness or darkness), such preferences may contribute to the pathophysiology of mood disorders. Moreover, light manipulation based on an individual's temperament may offer a potential strategy for the treatment and prevention of mood disorders. This study aimed to investigate the association between affective temperaments and light preference in apparently healthy individuals.
Methods: This opt-out study included data from 130 apparently healthy participants. Multiple regression analyses using the forced entry method were performed for each temperament score as the dependent variable, with age, sex, light preference (brightness or darkness), morning light exposure (yes or no), and mobile phone use before sleeping (yes or no) as independent variables.
Results: Depressive, cyclothymic, and anxious temperaments were significantly associated with a preference for darkness over brightness, whereas hyperthymic temperament was significantly associated with a preference for brightness over darkness. No significant light preference was observed in individuals with an irritable temperament. The adjusted R2 values in the multiple regression analyses were low, indicating that the effects of light preference on temperaments were modest.
Conclusions: Depressive, cyclothymic, and anxious temperaments are associated with a preference for darkness, whereas hyperthymic temperament is associated with a preference for brightness. These findings suggest that light exposure interventions tailored to temperament type may contribute to treatment and prevention of mood disorders.

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Rueter, K., Jones, A. P., Siafarikas, A., Chivers, P., Prescott, S. L., & Palmer, D. J. (2021). The Influence of Sunlight Exposure and Sun Protecting Behaviours on Allergic Outcomes in Early Childhood. *International Journal of Environmental Research and Public Health*, *18*(10), 5429. https://doi.org/10.3390/ijerph18105429

Abstract:
The dramatic rise in allergic disease has occurred in tandem with recent environmental changes and increasing indoor lifestyle culture. While multifactorial, one consistent allergy risk factor has been reduced sunlight exposure. However, vitamin D supplementation studies have been disappointing in preventing allergy, raising possible independent effects of ultraviolet (UV) light exposure. The aim of this study was to examine whether UV light exposure influences the development of allergic disease in early childhood. Direct sunlight exposure (290-380 nm) in early infancy was measured via UV dosimeters. Outdoor exposure, sun protective behaviours, and allergy outcomes were assessed over the first 2.5 years of life with clinical assessment appointments at 3, 6, 12 and 30 months of age. Children with eczema had less (p = 0.038) direct UV light exposure between 0-3 months of age (median (IQR) 747 (473-1439) J/m2) than children without eczema (median (IQR) 1204 (1717-1843) J/m2); and less outdoor exposure time (7 min/day) between 11 a.m. and 3 p.m. compared to children without eczema (20 min/day, p = 0.011). These associations were seen independent of vitamin D status, and after adjusting for other potential confounders. Whilst we could not find any associations between direct UV light exposure and other allergic disease outcomes, exposure to UV light appears to be beneficial in reducing the risk of eczema development in early childhood. Further research is required to determine optimal levels of UV light exposure while balancing the potential risks.

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Williams, S. N., & Dienes, K. A. (2014). Sunscreen Sales, Socio-Economic Factors, and Melanoma Incidence in Northern Europe. *SAGE Open*. https://doi.org/10.1177/2158244014559023

Abstract:
In this ecological study, we drew upon recently published melanoma prevalence data, and compared them with historical market data and published socio-economic data to test for an association between historical sunscreen sales (1997-1999) and recent melanoma incidences (2008 and 2012) in 24 countries in Northern Europe. We also explored associations between current melanoma incidences and historical data on the following socio-demographic indicators: income, urbanization, and population aging. Melanoma incidences were higher in high-income countries where sales of sunscreen were also higher. Our results show that, at the population level, income was significantly associated with melanoma incidences, $\beta = 0.0003$, t(19) = 3.104, p ¡ .006, and that increased sunscreen sales has not prevented higher income populations from being at higher risk of melanoma.

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Theoretical Frameworks

Glimcher, P. W., & Tymula, A. A. (2023). Expected subjective value theory (ESVT): A representation of decision under risk and certainty. *Journal of Economic Behavior & Organization*, *207*, 110–128. https://doi.org/10.1016/j.jebo.2022.12.013

Abstract:
We present a descriptive model of choice derived from neuroscientific models of efficient value representation in the brain. Our basic model, a special case of Expected Utility Theory, can capture a number of behaviors predicted by Prospect Theory. It achieves this with only two parameters: a time-indexed payoff expectation (reference point) and a free parameter we call predisposition. A simple extension of the model outside the domain of Expected Utility also captures the Allais Paradox. Our models shed new light on the computational origins and evolution of risk attitudes and aversion to outcomes below reward expectation (reference point). It delivers novel explanations of the endowment effect, the observed heterogeneity in probability weighting functions, and the Allais Paradox, all with fewer parameters and higher descriptive accuracy than Prospect Theory.

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Datasets

Hollis, D., McCarthy, M., Kendon, M., Legg, T., & Simpson, I. (2019). Haduk-grid—a new uk dataset of gridded climate observations. *Geoscience data journal*, *6*(2), 151–159. https://doi.org/https://doi.org/10.1002/gdj3.78

Abstract:
HadUK-Grid is a new dataset of gridded climate observations for the UK produced by the Met Office Hadley Centre for Climate Science and Services. The dataset interpolates in situ observations to a regular grid using methods developed in a previous equivalent dataset that had been made available to users since 2002 through the UK Climate Projections project (UKCIP02, UKCP09). The new dataset differs from the existing one in a number of key respects: higher spatial resolution, longer time series for some variables, improved consistency with regard to the pre-processing of station observations, the use of publicly-accessible ancillary data sources, a revised calculation sequence for some variables and improved version control. This makes for a dataset that is more internally consistent, more traceable and more reproducible. The result is a dataset of key UK climate variables of up to 1 km resolution from 1862 for monthly rainfall, 1884 for monthly temperature, 1891 for daily rainfall, 1929 for monthly sunshine and a wider set of variables with start dates from the 1960s to support the need for national climate monitoring and climate research.

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Vo, T. T., Hu, L., Xue, L., Li, Q., & Chen, S. (2023). Urban effects on local cloud patterns. *Proceedings of the National Academy of Sciences*, *120*(21), e2216765120. https://doi.org/10.1073/pnas.2216765120

Abstract:
Urbanization extensively modifies surface roughness and properties, impacting regional climate and hydrological cycles. Urban effects on temperature and precipitation have drawn considerable attention. These associated physical processes are

also closely linked to clouds' formation and dynamics. Cloud is one of the critical components in regulating urban hydrometeorological cycles but remains less understood in urban-atmospheric systems. We analyzed satellite-derived cloud patterns spanning two decades over 447 US cities and quantified the urban-influenced cloud patterns diurnally and seasonally. The systematic assessment suggests that most cities experience enhanced daytime cloud cover in both summer and winter; nocturnal cloud enhancement prevails in summer by 5.8%, while there is modest cloud suppression in winter nights. Statistically linking the cloud patterns with city properties, geographic locations, and climate backgrounds, we found that larger city size and stronger surface heating are primarily responsible for summer local cloud enhancement diurnally. Moisture and energy background control the urban cloud cover anomalies seasonally. Under strong mesoscale circulations induced by terrains and land–water contrasts, urban clouds exhibit considerable nighttime enhancement during warm seasons, which is relevant to strong urban surface heating interacting with these circulations, but other local and climate impacts remain complicated and inconclusive. Our research unveils extensive urban influences on local cloud patterns, but the effects are diverse depending on time, location, and city properties. The comprehensive observational study on urban–cloud interactions calls for more in-depth research on urban cloud life cycles and their radiative and hydrologic implications under the urban warming context.

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